The Bailey Boys

By Cherub Log

The following comprise extracts from data created by Historical Records of Australian Science, “The Bailey Boys” by Walter Fielder-Gill; “Radar at Sydney” by Robert Slatyer; an address given by Bob Slatyer at the Bailey Boys 50th anniversary Reunion September 1994; and biographical notes compiled by John Medhurst. The author acknowledges all these references.

In 1941, the Department of Physics, University of Sydney was selected to train men in the science of Radio Location, later to become known as Radar. The major thrust for this was through the Royal Australian Air Force, which at the height of its influence established 142 ground Radar installations in the SW Asia Pacific region. The Royal Australian Navy also participated in this program to a lesser degree than the RAAF, mainly because the RAN had a limited number of ships in which Radar could be installed and effectively operated. The man charged with the responsibility of developing and delivering the lengthy and high pressure training course was Professor Victor A Bailey, University of Sydney. A natural consequence was that Victor Bailey’s charges came to be known as Bailey’s boys, and subsequently, The Bailey Boys.

The first intake, mainly, but not all, second year undergraduates of Sydney University, commenced their training on the 15th September 1941, concluding in February 1942. Thirty eight of these then went on to eight weeks administrative training at the University of Melbourne, and upon completion were commissioned as Pilot Officers RAAF. Then followed twelve weeks training on secret Radar specifics at RAAF Richmond.

Upon entering the initial training, the intention was that graduates would join the RAF to participate in the European war, but when Japan entered the war in December 1941, all were retained to assist in Australia’s defence.

The second course commenced in March 1942 with undergraduates from five Australian universities. In this class were fifteen RAN trainees, the only RAN officers to be trained in the Bailey Boy program. Fourteen of the initial fifteen successfully completed the University of Sydney training. They were then sent to Flinders Naval Depot for 6 weeks officer training, followed by a period at what was to become HMAS Watson at Sydney’s South Head. At South Head they familiarized themselves with contemporary Radar equipment, and were then each sent to different ships and shore establishments for operational duties.

There were three more courses throughout 1942 and to January 1943, all to provide the RAAF with Radar specialist officers. The Army then enrolled men in two courses, the last one concluding in March 1944. In total, there were 249 Bailey Boys. Of these, 160 were commissioned in the RAAF, 14 in the RAN and 75 in the Army.

It is well beyond the scope of this chapter to give even an abridged summary of the University of Sydney training content. However, the following will offer a glimpse into the education process provided to the Bailey Boys.

The accent was on understanding the basics of the technology by a thorough examination of the underlying mathematics and physics, supplemented where appropriate by exercises. Some of the topics included analyses of complex circuits using differential equations and a vector approach to the steady state, and the use of operators and complex numbers. These techniques were applied to concepts such as coupled circuits, transmission lines, attenuation and wave generation to name just a few. In all about 125 mathematical equations were examined and used. There were lectures on topics such as thermionic valves,

cavity resonators, types of oscillators, amplifiers, phase inverters and harmonic resonators. As well students studied metalwork, woodwork, the use of equipment and safety considerations. Wave form generation and propagation received a lot of attention. To assist in comprehending the advanced mathematical treatments, basic maths such as trigonometric and hyperbolic functions, differential and integral calculus and Fourier Analysis were thoroughly explored. Throughout, there were 34 major exercises to be completed, regular tutorials, and periodic one hour examinations.

The desired outcome of this intensive training program was to create a cadre of technical officers who would be capable of assuming lead roles in the design, development, installation, and on occasions the repair of obscure operational faults, of Radar technology. As well, these men would be required to devise Radar counter measures, to assist in the creation of maintenance handbooks for the various Radar models being produced, to liaise with contractors and civilian manufacturers, to be the administrators of Radar installations and to be the mentors of the maintenance technicians. All this after an incredibly short period of about 12 months training. Considering that all were second year university undergraduates aged around 19 upon commencement of their training, the desired outcome became a remarkable success.

Overall, the consensus opinion shared by the Bailey Boys is that the program was very worthwhile. There are however supporters and detractors in specific areas. Some feel that the exhaustive study of the underlying theory provided them with the ability to “think outside the nine dots” when addressing any of the problems encountered when operational, and that this was most valuable. There are others who feel that lesser theoretical treatment of some topics such as alternating current theory would have allowed more time to study some of the practical considerations such as antenna design, because antenna efficiency is key to the success of any Radar. Perhaps Professor Alf Pollard’s question summarizes this apparent dilemma, “Could we have won the war without knowing about Fourier Theory?” Alf Pollard’s question is rhetoric, and we will never know the real answer.

RAN Bailey Boys served in the HMA Ships Australia, Shropshire, Hobart, Manoora, Bataan, Yandra, Kanimbla, Westralia, Faye C, Kybra, Townsville, Swan. As well as these shipboard responsibilities, Bailey Boys had different assignments as Port Radio Officers, Dockyard Officers, Instructors, Installation Officers, Radar Counter Measure Officers. They served in various Papua New Guinea east coast locations such as Madang, Lae, Aitape. As well they were on the New Guinea west coast, and further north and west of what is in 2004, Irian Jaya, into the Indonesian islands of Sulawesi and the Halmaheras. In terms of wide ranging operational locations, the cream on the cake, so to speak, was that two were in Tokyo Bay for the Japanese surrender.

Following are snapshots of the WW2 experiences of the 14 RAN Bailey Boys commissioned. Except for those entries marked with **, the information has been provided courtesy John Medhurst.

George Campbell : Did not complete the Bailey Boy course. Demob 20/5/46 as Lt(Sp)

Richard (Dick) Coyle: 1942 Rushcutter & Watson. 1943-44 Radar Officer Manoora. 1944-46 Port Radar Officer Cairns and Darwin.

Kenneth Andrew Glover **: Demob 20/5/46 as Lt(Sp)

Collins Greaves **: Demob 24/1/46 as Lt

John (Jock) Robert Hornsby: 1942-43 Rushcutter & Watson. Directed to specialised work on Radio Counter Measures (RCM) Brisbane & Darwin. 1944-45 Shropshire and other ships with RCM equipment. Demob 18/2/1946 as Lt(Sp)

Norman Louat **: Rushcutter, Broome, Moreton Westralia, Madang, Bingera, Aitape. Demob 7/3/46 as Lt.

Ronald (Ron) Joseph Lukies: 1942-43 Rushcutter & Watson. 1943 Radar Section Navy Office preparing standing orders and instructions for Radar personnel, analysis of Radar faults and improving component design. Subsequent short service in HMASs Townsville and Swan. Later to Radar-Radio Workshop at Leichhardt, then to HMAS Bataan. Demob 1946

Alistair John MacKenzie: 1942-43 Rushcutter & Watson. 1943-45 Radar Officer HMAS Australia. Demob 17/9/45 as Lt (Sp)

Archibald (Archie) John McArthur: 1942 Rushcutter & Watson. 1943 Williamstown Dockyard, Brisbane Dockyard fitting of shipborne Radar. 1944 New Guinea, maintenance of shipborne Radar from Madang to Milne Bay. 1945 Brisbane dockyard Radar maintenance. Demob 30/11/45 as Lt(Sp)

Colin William McIvor: 1942-43 Rushcutter & Watson. 1943 Radar Officer HMAS Hobart until Sydney return for damage repair. 1943-44 Yandra operator training and convoy work. 1944-45 Assistant PRO Melbourne. 1945 HMAS Semaphore PRO Adelaide fitting out AMS. Demob 6/2/46 as Lt(Sp)

John Philip Medhurst: 1942 Cerberus OD Signal School. 1942-43 Rushcutter & Watson. 1943-44 Radar Officer Kanimbla. 1944-45 Instructing at Watson. 1946-47 Radar Officer Warramunga and Bataan. Demob 6/3/47 as Lt(Sp).

Daniel (Dan) Frederick O'Keeffe: 1942-43 Rushcutter & Watson. Then to Brisbane fitting out basin doing Radar installations. Then to Base Radar Milne Bay and Madang. Then Radar Repair ship Faye C working around New Guinea. 1946 to Brisbane fitting out basin again. Demob 19/11/46 as Lt(Sp)

Robert (Bob) Thomas Slatyer: 1942-43 Rushcutter & Watson. April 43 – June 43 HMAS Hobart. June 43 – October 43 Watson writing A76 handbook. October 43 – January 46 Radar Officer Shropshire. January 46 – September 46 HMAS Leeuwin. Demob 26/9/46 as Lt (Sp)

Clive Reginald Taylor: 1942-43 Rushcutter & Watson. 1943-46 Section 22, Office of Chief Signal Officer GHQ. SWPA Brisbane, RCM work. Demob 16/3/46 as Lt(Sp)

Ronald (Ron) Henry Whitten: 1942-44 Rushcutter & Watson. Operator training HMAS Kybra. 1944-45 Radar Officer HMAS Hobart. 1945-46 Cerberus. Demob 9/3/46 as Lt(Sp)

** At the time that John Medhurst was compiling the foregoing information, Greaves and Glover were deceased, and Louat could not be located. Hence a lack of information about these three.

In conclusion, to quote Bob Slatyer, "Whatever the position to which they were appointed, the Navy Bailey Boys consider they were privileged to have been able to attend the course and that the instruction given was of great value to them during their Service career."

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WW 2 Wireless & Radio Mechanics

By Cherub Log

In September 1939, Australia followed Britain and declared war on Germany. At that time, the impending hostilities were half a world away, and posed little threat to Australia. In December 1941 when the Japanese launched their assaults on nations bordering the Pacific Ocean, matters changed dramatically. Instead of being an aggressor in a conflict 12,000 miles away, Australians were faced with the task of defending their domain from attack by a powerful, fiercely aggressive, determined and very close invader.

Traditionally and for organisational purposes, the Navy had branches of Engineering, Gunnery, Navigation, Communications, Supply, Electrical and Medical. Within the Communications branch there were the visual signallers, colloquially called the "bunting tossers", and the Telegraphists, aka "sparkers". The Telegraphist's main role was to operate the wireless telegraphy equipment communicating by Morse Code. Their subsidiary role was to maintain the equipment, which in the immediate pre war days, was fairly simple.

The challenge to 12,000,000 Australians of defending their vast land area encompassed by about 4,000 miles of coast line, equipped with meagre and largely outdated defence technology was daunting. To meet the challenge, many initiatives such as accelerated recruitment into the three armed services and mobilisation of industry to support a war effort were implemented. In the total context of this scenario, one of the many initiatives was the creation of a new branch of the Royal Australian Navy, the Wireless Mechanic branch.
In the early 1940s, the Telegraphists quickly found that the demands on their time and skills to handle the substantial increase in wireless traffic, as well as to man and to implement a training program to meet the needs of the sudden big increase in recruits was becoming more difficult as each month passed. Coupled with this, there was a steadily increasing introduction of more technologically complex electronic equipment to the ships and shore establishments. It soon became clear that the maintenance role of the Telegraphist could not continue. To address this need, the new title of Wireless Mechanic was conceived late in 1941, and introduced to the RAN early in 1942 (CN0194/42 refers).

In order to turn this concept into reality, selected personnel were to be given a basic training course of 6 months duration at the Melbourne Technical College, later known as the Royal Melbourne Institute of Technology (RMIT). This basic training was followed by equipment training at the RAN shore establishments of HMAS Rushcutter and HMAS Watson in Sydney, and at HMAS Harman and the Belconnen Transmitting station, both in Canberra. A few of the selected personnel came from existing Naval ranks, but the majority was recruited from civilian life. These then became what we know today as the Hostilities Only Radio Mechanics (HO RMs).

Radio Direction Finding (RDF) was the name given initially to the very new and top secret device which could "see" targets over the horizon, and at night, by showing on special equipment the range in yards, and bearing relative to the ship's head or to the compass. As well, for detecting aircraft, it -could show the angle of elevation necessary for training the anti aircraft guns. Various models of this technology were developed, and it logically fell to the Wireless Mechanic to instal and to maintain it. The title RDF was soon

changed to that of RADAR, an acronym of Radio Direction and Ranging. As the title Wireless Mechanic was then no longer completely descriptive, the maintainers' title was changed to Radio Mechanic. The Radio Mechanic (RM) then became responsible for the satisfactory performance of all electronic equipment in his ship. This was quite a responsible task. This change occurred in 1943 (CNO 414/43 refers).

Within the space of 12 months intensive training, the RM had the responsibility of keeping all of a warship's Radar and communication equipment fully functional.

Typically, the recruits were in their early 20s, and had secondary school education to year 5 level. Good passes in mathematics and physics were preferred. There were exceptions such as an older recruit with a strong background in radio.

Following the mandatory medical examinations and probity checks, the new recruits spent their first six weeks in the Navy "square bashing" at HMAS Cerberus. Cerberus is a large Naval training establishment at Crib Point Victoria. Those six weeks instilled a sense of discipline in each recruit, and taught him some of the basics of Navy life. The recruit learnt how to wear and to look after his uniform correctly, how to carry out the various drill orders, and generally to understand the subtleties of Naval routine. The facetious homily of "If it moves, salute it; if it is stationary then polish it; but if it wont take polish, then paint it" was not too far from reality.

All RAN recruits had this initial indoctrination which was then followed by specialist training at the various schools within Cerberus. For example, the Telegraphists went to the Signal
School, the Stokers went to the Engineering School and so on. However, the Radio Mechanics were drafted to HMAS Lonsdale, a shore establishment located at Port Melbourne. Lonsdale became their home for the next six months in that this is where they slept, washed and ironed their uniform clothes and ate most of their meals. Each Monday to Friday, having had breakfast, they would travel to the Melbourne Technical College, later Royal Melbourne Institute of Technology (RMIT) for instruction in electricity, and in radio transmission and reception. The travel distance was not far, perhaps 7 kilometres, and for the earlier classes was on the back of an open tray 3 ton truck. Passenger comfort and safety were given low priority. Some later classes had the luxury of traveling by tram.

Not all RMs were billeted at Lonsdale. There were occasions when the population exceeded the capacity for accommodation. On such occasions, some RMs were billeted out in private residences, such as their own home if they lived in Melbourne prior to enlistment.

What happened subsequent to the basic training depended upon two factors. One was the instructors' assessment of each student's potential, and the other was the manpower needs. Most graduates were very keen to be given the training which would lead them to a sea going ship. However, there were a number of shore based manning requirements such as the Naval Transmitting Station at Belconnen Canberra, HMAS Melville in Darwin, HMAS Magnetic in Townsville. As well, the advanced training in Radar was carried out at HMAS Rushcutter, and later at HMAS Watson when that establishment was commissioned. So quite a few RMs missed the glamour and excitement of being front line to the enemy.

HO RMs were assigned to 194 ships and shore establishments between 1942 and the end of 1945. Of these, 122 were sea going vessels. It is estimated that 363 men qualified as RMs in the period January 1942 through August 1945.

In early 1945, the RAN recognised that with the imminent cessation of hostilities, most of the Hostilities Only (HO) sailors would be demobilised, potentially leaving the essential services unmanned. To address this eventuality, a recruiting program of 12 years continuous service was introduced later in 1945 for all branches of the service. This carried on for a number of years after.

A schedule of Radio Mechanics necessary to man the estimated post war Navy, dated 13 August 1945 and promoted by DTSR Captain Alan McNicol showed how critical the situation was deemed to be, with an estimate of just 5 serving members who would transfer to the permanent forces, leaving a shortage of 152. The schedule indicated that 101 of these 157 RMs would be destined to serve in the 54 naval vessels in commission at the time, 33 would serve in shore establishments and there would be a 'pool' of 14. He subsequently revised his estimate to 285. However, 8 months later on 25 April 1946, the CO of HMAS Watson, Commander Neil McKinnon, proposed a total of 171 RMs to man 36 ships and 11 shore establishments. This program called for a selective recruitment to achieve 15 classes at the rate of 8 classes per year. Class duration was to be 39 weeks (In fact it became 49 weeks).

Following recruit training at HMAS Cerberus, trainee RMs spent 6 months based at what was HMAS Torrens, Port Adelaide. Daily they would be transported to the then School of Mines, later to be absorbed into the University of South Australia, for basic training in electrical and electronic theory and practice. Graduates were then sent to HMAS Watson, Sydney for training in Radar or W/T equipment, according to the manning needs at the time. It was considered to be too onerous on the students to expect them to learn all of the W/T and Radar equipment at the time. So there was initial specialisation in W/T or Radar, with cross training a year or so later.

The first class commenced training at the School of Mines in January 1946, and the last class completed the initial training in April 1949. During this 40 months period, approximately 180 Radio Mechanics graduated from the School of Mines training program. Commander McKinnon's crystal gazing 3 years previously proved to be remarkably accurate.

Subsequently, the Radio Mechanic branch was folded in to the Electrical branch, and different conditions were introduced to meet the changing needs of the service.

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Snippets

By "Skip" Distance

This is a collection of incidents, stories, happenings, illustrating some of the fun and hazards of Radar technology in the mid 1940s to mid 1950s.

In May 1951 P O Radio Electrician Doug Hawke was assigned to maintain the 960 Air Warning Radar aboard HMAS *Australia.* His first problem to address was to get the Trigger unit operating reliably. After many hours of frustrating and patient but unsuccessful work, Doug solved the problem by withdrawing the unit from its cabinet, placing it on a stool, and causing all available forced air outlets to be directed at it.

The next problem was that the output Lighthouse tubes repeatedly kept "blowing", requiring replacement. Technical experts from the Leichhardt Radio Test Room were called in, and for a time there was much head scratching. Then PO RE John Scanlan noticed a blob of aerial insulation material hanging from

underneath the cable where it joined the aerial filter unit. Somehow the aerial run had turned to carbon. Cable was replaced, and that fixed the premature demise of the Lighthouse tubes.

While in attendance, the Leichhardt boffins were directed to the Trigger unit problem. Inspection revealed that the ventilation for the cabinets had been wired in reverse. The hot air was blowing back down over the heat source, and apparently had been so doing for a long time.

For a brief period while operating out of Hong Kong, Doug was required to surrender his proprietorship of *Australia's* 960 to a team of Intelligence people who connected a Panoramic Adaptor (Spectrum Analyser) to 960's antenna, for the purpose of intercepting Chinese and Russian transmissions.

Chief Radio Electrician Phil (Lofty) Watson, tells a story to illustrate the considerable value of Radar operations being in the hands of capable operators. To have excellent equipment is not sufficient if the best is required of the Radar system.

It was in the late 1940s that an exceptionally heavy storm on the NSW east coast caused a large harbour pontoon (about 10 by 15 metres) to break free of its moorings in Newcastle harbour, and to be driven into the nearby off shore shipping lanes. The Newcastle Harbour authorities immediately issued a "Danger to Shipping" signal, and requested the RAN to initiate a search and locate exercise. HMAS *Quadrant,* then under the command of Captain Sam Beattie VC, on loan from the RN, was despatched forthwith from Garden Island, and shortly after commenced Radar sweeps. As well as "all hands to lookout", the search Radars were the 293 and 277 10 centimetre sets suited to long range, supplemented by 974 (3 centimetre) navigation Radar.

After about an hour of nothing reported, one Radar operator reported an occasional very small blip occurring once every 3 or 4 antenna rotations. By persisting the operator was eventually able to confirm that "there is something there". *Quadrant* was conned to approach and finally when only a very short distance away, the almost submerged pontoon was seen wallowing in the still very heavy swell. At best, only a few inches of the pontoon were visible above the surface of the sea, and this only for a few seconds as the waves washed over it. Indeed a hazard to shipping.

Lofty's point is that whereas the Radar equipment was capable of picking up occasional echoes from the almost submerged pontoon, it was the skill and perseverance of the operator which caused the pontoon to be found. Finding the recalcitrant pontoon was one thing, taking it in tow and proceeding back to Newcastle harbour at less than 3 knots all night in an uncomfortable heavy swell, was another matter to be told elsewhere at another time.

Greg Sharp recalls that in 1948 there was a problem with the 286 long range Radar installed at Watson's Bay. The trace 'bloomed', the cause being a leakage through the double diode 6H6 connected to the grid of the CRO. A new component had just arrived from the UK, and it was called a solid state diode (later called a transistor). Greg fitted this and fixed the problem. It wasn't too many years later that the transistor became a household word.

Greg was a recipient of the R.N. Herbert Trust Fund Award for his work in adapting a Miller Transitron circuit to provide a stable linear sawtooth to improve the bearing accuracy of the 286 Radar.

Roy King was a HO RM, having joined the RAN as a "Rocky" on 29/10/1942. Following his recruit and technical training, an early appointment was to HMAS *Bunbury*, a Bathurst class minesweeper (Corvette). Roy reports:

Bunbury was fitted with both A272 and A276. Display for the A272 was the single line A scan image, whereas the A276 had the more advanced PPI display. A272's antenna was the big old square type.

Ray Brown, ex Ch RE, reports that 55 years on he still has a small tin containing gramophone needles, obtained from Naval Stores, as spares for the A272 rotary spark gap electrodes.

On the topic of rotary spark gap, the Frigate *Culgoa* and Corvette *Cootamundra* had A276 Radar which had a rotary spark gap attached to one end of the motor generator which in turn powered the A276. The rotor of the spark gap rotated at 3,000 rpm and it had 10 electrodes to arc over the stationary electrode, thus producing a pulse repetition rate (PRR) of 500 pulses per second.

When running, the spark gap was adjusted by means of a knob to bring the spark to a fine blue colour for optimum operation. The stationary electrode wore away rapidly, and was constantly replaced to keep the spark sharp. The amplitude of the initial pulse shown on the A scan was a good indicator that the spark gap needed adjustment. As the elecrode began to deteriorate, the amplitude of the pulse would diminish. The spark discharged the line/modulator which in turn fired the transmitter.

Ray also relates the following story about the fast anti submarine frigate HMAS *Quickmatch* during the early 1950s. *Quickmatch* was engaged in an anti submarine exercise with her consort *Queenborough*, both at slow speed in a big ocean swell, and in contact with a submarine. In this state a large blue pennant is shown to give visual indication that the ship has a submarine contact.

Quickmatch was flying the pennant when it wrapped itself around the 974 Radar aerial, bringing the aerial's rotation to a shuddering halt. Ray was in the operations room at the time, and seeing the aerial rotation cease for no apparent reason, cut the power immediately. Using his initiative, he grabbed the nearest tools he could see, which were a broken kitchen knife and a hammer, rapidly scaled the superstructure and cleared the bunting from the aerial's moving parts. 974's training motor was belt driven, and because of this and Ray's quick action, the motor did not burn out, and *Quickmatch's* 974 was operational again promptly.

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Operations Rooms HMA Ships WW2

By Lt (Sp) R Slatyer RANVR

My sea time was spent almost entirely in HMAS *Shropshire,* so I will describe my recollections of the situation as regards Operations Rooms in that ship.

In Shropshire we did not have a centralised Operations Room as I understand all ships now have. Instead we had a number of different locations each of which had a particular function. These were:

Navigation. Directly under the bridge was the Plotting Office. This had a table on which the appropriate chart would be spread under a glass panel. A spot of light from underneath was moved to follow the ships course and speed, and the person on watch would mark its position at intervals. There was an opening above through which the chart could be viewed from the bridge. We had an American SG Radar with PPI display (the only PPI we had) , mounted in the Plot.

Gunnery Control – Main Armament Surface Targets. The TS (Transmitting Station) was installed well down in the ship and forward of the boiler rooms. It was manned by Bandsmen with a Warrant Gunner in charge. The fire control table could be described as a 'mechanical computer", and was slightly smaller than a billiard table. Information fed into it would be:
* Ship's course and speed
* Target range available from either the optical rangefinder in the main armament director or from either of the 2 Radar displays in the TS. These were the 285 with antenna mounted on the main armament director or the 273 which was independent. At all times the Radar range was more accurate than the visual, although in good visibility there was little difference.
* Target bearing. In conditions of good visibility visual bearing was more precise than Radar but in poor visibility or at night Radar bearing was adequate for the purpose. Target course and speed was estimated from this information, adjustments applied for wind etc, all providing the necessary data for setting the guns.

Gunnery Control – High Angle Guns. Shropshire had four twin mounts of 4 inch HA guns and a type 285 Radar with antenna mounted on the HA director. These guns were used for long range anti aircraft defence. They were controlled by a gun control table similar to but smaller than that in the TS.

Gunnery Control – Auto Barrage Units. We had four of these units, one for each main armament turret. I think that once the Gunnery Officer on the bridge had given an order to use a particular turret to attack a particular aircraft, control of the operation was the responsibility of the Gun Captain in the turret.

Aircraft Warning and Interception. Air plotting Office. This was the closest we had to a modern day Operations Room, manned by Radar Plot ratings and a Specialist Officer in charge. *Shropshire* was fitted with a 281 air warning Radar. It was a powerful piece of equipment based on the technology of long range Naval W/T. but required careful attention to all aspects of fine tuning and maintenance as well as dedication to detail combined with great patience on the part of the operators to extract the best performance from it. Fortunately we had the right people to do that.

The information on positions of aircraft both enemy and friendly was recorded on a chart using the call sign "Porthole". The name "Porthole" was held in high esteem throughout the fleet and all members of the ship's company were proud to be associated with it.

Regarding other ships, I think that cruisers and destroyers would have had similar decentralised arrangements for navigation and gunnery control, taking into account the guns fitted. Their air warning Radar would have been used simply for air warning reporting directly to the bridge. HMAS Australia may have had an Air Plotting Office, but it would have been much simpler than in Shropshire. The reason that *Shropshire* was different was that before the hand over from the RNB, a complete set of current Radar and associated equipment was fitted.

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Radar Operator Training.

By Ron Whitten Lt (Sp) R.A.N.

Physical Situation

Training was done at South Head, an outpost of H.M.A.S. *Rushcutter*, which was responsible for the administration, while the school was run by RDF experts.

Built in 1942 on the South Head's bluff was a school with classrooms and, right on the ocean's edge, another building housing the training Radars – an Australian 286 Air Warning set and a 272 Surface Warning set. These were used for training both operators and mechanics. Like at Rushcutter there was no accommodation at the school, so all personnel lived out, coming by bus or tram to South Head each morning and climbing the hill to assembly and roll call in the school grounds. Lunch was provided in an old church on the site.

Training Classes

Operator training came under School Master John Gloury, who delegated the task of arranging lessons, content and division of training between classrooms and operational sets. The lessons involved the principles of RDF, the kind of sets available in the RAN, how to turn them on and how to operate them. The lessons included how to plot and report the data received, and how to estimate aircraft height given the range at which aircraft were detected. The time table had to take into account the subject matter being taught, the availability of classrooms and the availability of sets for operators to train on, as these were also being used for mechanic training. Because operators would be going mainly to Corvettes it was essential that they understood fully the intricacies of the 286 and 272 that they would be responsible for as well as the essentials of plotting. Other ship operators had to know how to integrate RDF operation with gunnery.

By March 1943 the RN had well developed RDF operating principles and training methods, and these were used as a basis of the Australian training system. The RN also provided training films, like one showing RDF being used on a Corvette to detect submarine periscopes and the events following until the sub was sunk. This was a favorite among trainees.

Often there would be no room in the operating hut, so classes were allowed to spread out on the rocks nearby, often enjoying the sun more than the lessons. This was ample opportunity for the P.O. Coxswain, who would sneak up on them in an effort to find some-one skulking. Mostly he was frustrated.

Training at Sea.

There was a constant demand on Navy Office to provide a training ship, but it took a long time to materialise. In the meantime, H.M.A.S. *Kybra*, a cattle boat that worked between Albany and Fremantle in peacetime, had been converted for Asdic training. It became a de facto RDF training ship when it arrived in Sydney with a crew of "uncontrollable" RDF operators who had recently returned from action in the Mediterranean theatre and were not greatly impressed by the local "pusser" regimes. It was decided they would be replaced by a group of first time trainees, but by the time Kybra was ready to leave the old crew was back. I had joined the ship as the Radar officer, and wasn't very happy at what had happened. We were hardly out of the harbour before I was called to the operating room to be told the aerial of the 286 wouldn't turn. The aerial was controlled by an Asdic trainer, which I knew nothing about. Luckily, while leaning on the trainer, my fingers found a switch underneath, which set the aerial going as soon as it was turned. The "rascals" must have decided that I knew what I was about and we became well acquainted. The Jimmy of Kybra disliked the RDF people, who didn't work ship, so he found as many difficulties as he could for them. Whilst in the Eden area the RDF operators had to take the whaler for a row each morning. A great lark – around the nearest bluff that hid the whaler from Kybra and onto the rocks for fresh oysters, some of the best ever tasted.

H.M.A.S. Hobart

Towards the end of 1944 nearly all the Radar operators in the RAN had been trained or re-trained, and it was time to move on. (By this time the American name Radar was being used.) So in October, I was appointed to *Hobart* as second Radar Officer. The ship was still refitting at Cockatoo Dock, where the dockies had gone on strike to demonstrate to Admiral Keyes, RN, that they were unwilling to work. Working with dockies was tricky. Carrying aboard an urgently needed battery nearly caused a walkout.

Because I had been in charge of operator training for so long I knew the best and the worst of them, and used this knowledge in choosing Hobart's operator crew. I had to allow that I would be expected to choose the best, so asked for more and got nearly all I wanted. There were certainly some very good operators among them.

When the Cockatoo Dock refit was finished just before Christmas, *Hobart* went to the Jervis Bay area to work up. On Christmas Eve the ship was preparing for a relaxed Christmas Day. But just after midnight the Surface Warning operators picked up what was definitely a submarine periscope at about twenty miles to the south east. So it was up anchor and back to Sydney, with much questioning as to whether it had been a submarine detected that far away. I got a final answer to that question many years later at a lunch for former Ikara missile team members. Hugh Jarret, who was second gunnery officer in *Hobart* at the time, had stayed in the Navy after the war and had been involved with the Ikara missile development. Hugh had been in Germany and met up with submarine people who confirmed that a submarine had been in the area at that time and sunk a small tramp steamer.

This long range detection happened because *Hobart* had been fitted with the latest British Radar sets, which performed magnificently, and *Hobart* had good Radar operators. Later at Balikpapan on the east coast of Borneo, Colin Churchett, the operator of the 281 Air Warning set, picked up an echo in the grass that no-one else could see, which eventuated into a Japanese bomber coming from inland Borneo. This was followed in on the 281, and then handed to the gunnery Radars that helped the guns shoot the aircraft down. This was at night so the aircraft was never seen, just an echo in the grass until it appeared on PPIs as a series of dots coming to earth. While the aircraft was approaching the Fighter Director Officer had it on the Kryatron display and was calling up fighters from nearby carriers, but they didn't scramble in time to be of any use.

Another example of how good were *Hobart's* Radars was at the Brunei landings. Stooging around outside Brunei harbour, the Surface Warning set picked up a ship at around forty thousand yards. The usual report went out "Skunk bearing so-so, range so-so." It was well known that the approaching ship carried General Douglas Macarthur, but the US Navy ships accompanying took up the cry "Does the skunk smell?" "How badly does that skunk smell?" And questions of that ilk which went on for about five minutes when the US Admiral in charge called it a day.

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Supplies

By Cherub Log

French general of history is reputed to have stated that an army marches on its stomach. A similar sentiment might be attributed to the survival of technology in that unless there is a constant supply of spare parts and equipment, the technology will not survive.

Behind the front line of Radar equipment and operational personnel, during WW2 there was a constant stream of communiqués dealing with many aspects of supply. Some of the originators and recipients of these communiqués, which incidentally were categorised as either Most Secret, or Secret, were C in C East India, ACNB, PMG, a certain Colonel Jones who was Controller of Radio Supplies, Ministry of Munitions, 1st Naval Member, 2nd Naval Member, 3rd Naval Member, DCNS, Department of Munitions, Naval Stores South Melbourne, DNS, C in C China, NZNB, and the Naval Officers Commanding the stations at Durban, Colombo, Fremantle, Bombay, Kilindini and Drogue. There were many more. This alone added a degree of complexity to the appropriate management of the requirement to provide a suitable infrastructure in which the maintenance personnel could work effectively.

For some of the items, the classification of Most Secret is perhaps understandable. Examples were test equipment such as Field Strength Receiver, Wavemeters, Portable dipoles and signal generators all operating at 176 Mcs and 200 to 214 Mcs. Enemy knowledge of these might have given a clue to the Allied Radar equipment. Dozens of other items on messages classified as Most Secret seem to be an over use of the Most Secret classification. Examples were Set of chisels small; 6” warding file; Set of BA dies (0-10BA); 60 watt electric soldering iron. How unauthorised knowledge of the requirement of these items could have given the enemy a tactical advantage is a mystery.

The establishment lists of spare parts for major centres such as Durban, Colombo, Fremantle read like all of Dick Smith’s 21st century stores, multiplied by a factor of 10. For example, a few of the hundreds of items were valves diode 6H6 quantity 480; valve triode 6AC7 quantity 880; Capacitor 100 µµF 400 V working quantity 1,040; Resistor 1 M ohm 1 watt quantity 2,480.

The organisation of maintenance items was thorough as the following examples illustrate

a) The standard ship’s set of maintenance tools, perhaps 30 items such as steel rules, engineer’s hammer, hand drill, long nosed pliers and so on.

b) The list of about 50 installation consumable stores, such as empire tape, torch batteries, emery cloth, red coaxial putty, carbon tetrachloride.

c) A Most Secret letter written 2nd March 1942 by Lt Cdr G.C.F. Whittaker to the O.I.C P.M.G. Laboratories Melbourne confirms the formal order for various items such as Power Supply Alternators, Aerial Arrays, Meggers, Avometers, Beat Frequency Oscillators, Tube Testers.

d) Another Most Secret letter written 14 January 1942 by Lt Cdr Whittaker to the O.I.C., C.S.I.R Radio Physics Laboratory, on behalf of the C in C East Indies Station advises that he (Whittaker) is in Australia for the purpose of arranging supply of various major items such as 40 sets of Australian type S.W. 176 Mcs, and 200 – 214 Mcs R.D.F sets, complete with all essential ancillary gear, 40 aerial arrays, and long lists of test equipment, spare parts and tool kits.

Of course, none of the equipment provided to whomsoever ordered it was free of charge. All had to be properly accounted for. So as well as the extensive process of inventory control, there was additionally the accounting requirement. Here are some examples taken from an account dated 11 February 1942:

a) 14 cathode ray tubes, total cost £45.7.8
b) 3914 valves various, total cost
£10,972.17.5
c) 1296 batteries. Total cost £96.0.0

d) I only 18KVA 1 phase 50 cycle 220/240V 1500 rpm alternator
£180.0.0
e) 4 sets of TR switching units, total cost £109.8.0

This account comprised approximately 480 line entries, and a total cost of £109,818.12.5

Some of the transport arrangements for orders for shipment from Australia to the Eastern Fleet were per the following ships in the months shown:

SS Tandra. May 1942
SS Oresles. June 1942
SS Mulbera. July 1942
SS Rajula. August 1942
SS Queda. August 1942
SS Tandra. January 1943
SS Masula. February 1943
SS Madura. February 1943
SS Melore. April 1943
SS Tandra. May 1943
SS Mulbera. July 1943
SS Malkura. October 1943
SS Querimba. February 1944

The point of this article is to provide evidence that the design of WW2 Radar equipment, and hence the maintenance practices, were vastly different from what we now experience in the 21st century. To illustrate this point by a simple and familiar example, if today our home DVD player of VCR breaks down, either the whole item is discarded in favour of a newer bigger brighter model, or for the impecunious (most of us), the faulty unit is diagnosed, removed and replaced. The new unit typically will contain the 1940s equivalent of 15 thermionic valves, 80 resistors and condensers, and 140 pieces of insulated wire, all painstakingly hand soldered together make the required electrical connections. In the1940s, if our home radio set broke down we would have taken it to a repair shop, where the failed tube (thermionic valve) was replaced, or the open circuit solder joint would be resoldered or whatever else needed to be done to allow us to continue listening to the likes of “Blue Hills” or “Dad & Dave”.

So, whereas today the maintenance engineers might need a dozen or so sub assemblies for replacement needs, and have the luxury of built-in fault finding devices and in some cases the ability to program around the faulty unit, in the 1940s the maintenance teams needed to be supplied with hundreds, perhaps thousands, of the individual components. As well they required a number of discrete items of test equipment, and the availability of carefully drawn circuit diagrams to enable the failure to be isolated to in many cases, a burnt out resistor or a weakly emitting thermionic valve.

To provide the front line 1940s maintenance personnel with all the bits and pieces necessary to achieve the required high rate of fault repair, the procurement and supply infrastructure also had to be at a high level of efficiency and effectiveness. Given that the vast majority of maintenance needs were carried by very slow sea transport (no overnight helicopter or large air transport in those days), a lot of forward planning had to be done. As if this were not enough to contend with, there was also the contingency plans to be laid in the event one or more of the supply ships was sunk in enemy action.

In summary, the 1940s function of logistical inventory management of Radar associated equipment was, by comparison with today’s program, a huge and very detailed task, and played a vital part in ensuring the Radar technicians had the logistical support for them to do their work.

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RADAR Basics

By Cherub Log

For most of those reading these Radar and related articles, the concept of the technology will be familiar. For those however who have had little or no exposure to Radar, this article will provide some of the basics.

A simple analogy is to imagine you are standing at Echo Point in Sydney's Blue Mountains, and you shout "Hello". Within a second or so your ear detects an audible echo. Now as the speed of sound is known, and if you can accurately time the interval between your shout and the echo, the distance to the obstruction which caused the echo, e.g. mountain rock face, can be simply calculated. The formula is d distance = v velocity (of sound waves) multiplied by t/2 (half the elapsed time). The half is to allow for the sound to travel in both directions.

For Radar, instead of sound waves we have electromagnetic waves which have a velocity of 300 million metres per second. To measure time, there are a number of different electronic clocks which can be used and which can be highly accurate. As well, to do the arithmetic of t (time) multiplied by v (velocity) = d (distance), there are more electronic calculators. To illustrate, if a pulse of electromagnetic transmission is sent and the returned echo comes in 50 microseconds, the target is distant 7.5 kilometres as follows: d = v times t. Thus d = 3 x 10 to the power of 8, times 50 times 10 to the power of minus 6 =15,000 metres = 15Km. Thus the target is 7.5 Km distant

There are variations on this principle. One such is known as the Doppler Effect. Here it is not the time difference which is measured but the frequency difference. To explain Doppler effect, imagine you are standing on a railway station and you hear an approaching train, which in this case is an express train to pass straight through your station. As the train approaches, not only does the sound of it change in volume, but also the frequency or pitch of the sound changes slightly. In fact it increases as the train approaches, then decreases as the train leaves your station. This effect is caused by the velocity of the train's sound waves being increased by the velocity of the train as it approaches, and decreased similarly as the train roars off into the distance. So it is with electromagnetic waves in that there is a small frequency shift when there is a radial difference in range occurring between the Radar set and the target. As an example, at an operating frequency of 10 GHz (10,000 MHz or 3 centimetre wavelength) a radial velocity of 1 nautical mile (1.883 kilometres) per hour provides a Doppler frequency shift of 34 Hz. It should be noted however that the Doppler effect occurs only when there is a radial difference between the Radar set and the target. If both the Radar set and the target are travelling in a straight line at the same speed, Doppler effect will be zero because the relative distance separation remains constant, and thus no frequency shift. As well, if the target is moving in a circular path of constant radius about the Radar set, again there will be no frequency change, thus no Doppler effect.

In 1937 when the Home Chain system was introduced, there was one Radar function, that of early warning. In the 21st century there are many functions. Some are Control (Air Traffic Control), Navigation (Terrain Following Radar), Dock (Capsule Docking Radar), Land (Microwave Landing System), Map (Side-looking Radar)

All Radar systems need to obtain certain information. Typical are range, velocity and acceleration, azimuth direction, elevation angle, target signature.

In the immediate pre WW2 days, designs of the various thermionic valves limited the frequency at which a Radar system could operate. Typically this was in the high frequency range up to 50 Megacycles*, a wavelength of 6 metres. With the developments of the magnetron and klystron, frequencies up to 10,000 Megacycles , wavelength 3 centimetre, could be achieved. In the 21st century the Radar bands assigned by the International Telecommunications Union are as follows:

BAND	FREQUENCIES
VHF	138 – 144 MHz
	216 – 225 MHz
UHF	420 – 450 MHz
	890 – 942 MHz
L	1215 – 1400 MHz
S	2300 – 2500 MHz
	2700 – 3700 MHz
C	5250 – 5925 MHz
X	8500 – 10,680 MHz
Ku	14.4 – 14.0 GHz
	15.7 – 17.7 GHz
K	24.05 – 24.25 GHz
Ka	33.4 – 36.0 GHz

* The term cycles has been replaced in recent years by the term Hertz

The relationship between frequency , wavelength and velocity is constant where wavelength equals velocity divided by frequency. As an example, a wavelength of 30 centimetres will be derived from a velocity of 3 X 10 to the power of 8 divided by 1,000 MHz (1,000 X 10 to the power of 6.)

Again for the benefit of those not familiar with Radar, following are brief explanations of some of the words and terms used in these articles:

75 ohm coax Coax is the coaxial cable used to carry electromagnetic signals. The 75 ohm does not refer to standard direct current (DC) resistance. Typically the DC resistance in coax is zero. Here it is the impedance to alternating current signals. For maximum signal transference, the coax should exhibit the same impedance as that of the device to which it is attached, e.g. the receiving aerial, or the video amplifier etc.

A scan This is a single line horizontal trace on a cathode ray oscilloscope (CRO). At the left hand end, the large vertical pulse indicates the initial transmission signal. To the right along the trace, a returned echo is shown as another smaller vertical pulse.

A scope See “A” scan

Bedstead array Using a bit of imagination, this antenna looks very much like an old fashioned wire spring bed base, mounted on its long edge on the ship’s mast.

Bowden cable This is a strong flexible and usually lengthy cable used to transfer physical movement. For example, an operator in a Radar office turning a wheel that is connected by Bowden cable to the antenna on the mast head, can cause the antenna to move in the direction and by the amount that the operator desires

Double cheese This type of antenna looked like two half circular cheeses, but much larger.

Klystron Using the superhetrodyne principle of radio reception (see explanation of this), the klystron was used initially as a local oscillator. As the technology developed, more powerful klystrons were developed and used as transmitters.

Lantern Imagine an old fashioned cylindrically shaped lantern, but much larger. In this on the mast would be housed the Radar antenna, and in some cases much of the transmitting and receiving equipment.

M type transmission A 24 volt DC hand driven generator, when electrically connected to a similarly constructed motor, can cause the motor to turn in sympathy as the generator is turned. If the motor is mechanically connected to a Radar antenna, a Radar operator in the Radar shack could remotely turn the Radar antenna on the ship's mast.

Magnetron This was one of the main transmitters. It could produce electromagnetic signals at frequencies between 10,000 and 3,000 MHz, for pulse durations of less than 1 microsecond, at pulse repetition rates of hundreds per second and with peak power outputs of hundreds of watts.

Micro dog This was a high power transmitting triode, NT98

Micro pup This was a low powered transmitting triode, NT99

Modulator This is simply the device which regulates the frequency, and sometimes the duration of the Radar transmission pulses

Motor alternator Standard electrical power supplies in HM ships during WW2, and for some time after, was 220 volts DC. All electronic equipment operated on alternating current (AC) at different voltages. A motor alternator was a DC electric motor mechanically connected to an alternator. Thus as power was applied to the DC motor, AC was delivered from the alternator.

PPI Plan Position Indicator was a circular Radar display (a modified cathode ray oscilloscope), with the source being at the centre of the circle. As the transmitter pulsed, a representative trace was projected on the screen emanating from the centre and extending to the periphery of the screen. A returned echo would be seen as a bright spot on the trace. As the antenna rotated, the PPI trace would rotate in synchronism. Thus not only the range of the target could be seen on the calibrated scale, but also its orientation in relation to ships head, of if desired, in relation to a fixed bearing such as magnetic or true north. Variations of this allowed the presentation of slant range of aircraft echos. Thus range, azimuth and altitude of aircraft could be quickly determined.

PRF Simply, pulse repetition frequency, or the number of transmitted pulses each second. These varied between Radars, but a PRF of 500 was typical.

Rx Shorthand for receiver

Sector sweep Refer to PPI. Instead of a 360 degree continuous rotation, some models were designed to allow backwards and forwards sweeps of a selected sector, e.g. 20 degrees both sides of ship's head

Spark gap This was one form of modulating transmissions. (See Jake Kerr's story of A272)

Superhetrodyne principle Amplification of electromagnetic signals is made more reliable by mixing the desired signal with one at a slightly different frequency,

and by selecting the resultant difference. Thus the reflected echo signal of a magnetron transmission at 10,000 MHz, could be mixed with a klystron generated local signal of, say, 10,009 MHz. There would be 4 resultant signals i.e. the original two, the sum (20,009 MHz) and the difference (9 MHz). Selection of the 9 MHz for further amplification would produce the best frequency to be used to create the displayed echo signal.

Thermionic valve This was the forerunner to the transistor which in turn was the forerunner to integrated circuits, used in the millions today in radios, TV, mobile telephones etc. In appearance, generally it looked like a normal electric light globe. The principle of operation was that a constant stream of electrons would be emitted from the heated cathode, and the quantity of these electrons would be varied by an electric signal applied to the grid, placed physically between the cathode and the anode, which because it had a high tension voltage applied, would attract the cathode emitted electrons. In this process, the amplitude of the signal coming in to the grid would appear greatly magnified when seen at the anode. There were many variations of this device. The distance which the electrons had to travel from cathode to anode was a factor which determined the frequency limits of the valve in question.

Thiratron (Thyratron) This was a high power mercury vapour triode used as a pulse modulator for transmitters

Tx Shorthand for transmitter.

Variac A mechanical hand operated device for varying the voltage output of an alternator

Wave guide At lower frequencies, radio signals can be successfully carried over copper wire. At higher frequencies this does not work at all well. Waveguide is rectangular section metal tubing, sometimes gold plated on the inner surfaces. UHF and higher radio signals carry much more effectively along the inside of waveguide material. The length of the waveguide can be many metres without significant loss of performance. The dimensions of the cross section must relate to the frequency of the transmitted signal. A 3 cm transmission uses 3 cm cross section waveguide for example.

Wave Guide Horn See wave guide. At the antenna, the transmission signal leaves the waveguide and is directed to the antenna via an aperture or horn. For example, if the antenna is a parabolic reflector, the horn is located at the focal point, which may be up to 50 centimetres from the nearest point of surface of the reflector.

Yagi array An antenna array named after its Japanese inventor. Essentially it is a straight rod pointing away from the ship's mast in horizontal orientation. The active element which is connected to the transmitter is a transverse element, generally about 30% along the rod from the mast end. Nearest the mast are 2 or 3 transverse elements, slightly longer than the active element. These are the reflectors. Then progressively located away from the active element in a forward direction, each slightly shorter than its predecessor and the active element are the directors. The net result is a highly directional antenna. Yagi antennas are common in domestic free to air television set ups.

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